

FORM PTO-1390 (Modified) (REV 11-2000)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER 217649US2XPCT	
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371				U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 10/018859	
INTERNATIONAL APPLICATION NO. PCT/JP00/04073		INTERNATIONAL FILING DATE 21 June 2000		PRIORITY DATE CLAIMED 25 June 1999	
TITLE OF INVENTION HYBRID CONSTRUCTION MACHINE AND CONTROL APPARATUS THEREOF					
APPLICANT(S) FOR DO/EO/US KAGOSHIMA Masayuki					
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:					
<ol style="list-style-type: none"> 1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. 2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. 3. <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below. 4. <input checked="" type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (Article 31). 5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371 (c) (2)) <ol style="list-style-type: none"> a. <input type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau). b. <input checked="" type="checkbox"/> has been communicated by the International Bureau. c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US). 6. <input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)). <ol style="list-style-type: none"> a. <input checked="" type="checkbox"/> is attached hereto. b. <input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4). 7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3)) <ol style="list-style-type: none"> a. <input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau). b. <input type="checkbox"/> have been communicated by the International Bureau. c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. d. <input checked="" type="checkbox"/> have not been made and will not be made. 8. <input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). 9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)). 10. <input type="checkbox"/> An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)). 11. <input type="checkbox"/> A copy of the International Preliminary Examination Report (PCT/IPEA/409). 12. <input checked="" type="checkbox"/> A copy of the International Search Report (PCT/ISA/210). <p>Items 13 to 20 below concern document(s) or information included:</p> <ol style="list-style-type: none"> 13. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98. 14. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included. 15. <input type="checkbox"/> A FIRST preliminary amendment. 16. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment. 17. <input type="checkbox"/> A substitute specification. 18. <input type="checkbox"/> A change of power of attorney and/or address letter. 19. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825. 20. <input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4). 21. <input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4). 22. <input type="checkbox"/> Certificate of Mailing by Express Mail 23. <input checked="" type="checkbox"/> Other items or information: <p>Request for Priority/Drawings (12 sheets) PCT/IB/304 Form PTO-1449</p>					

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.101) 10/018859		INTERNATIONAL APPLICATION NO. PCT/JP00/04073		ATTORNEY'S DOCKET NUMBER 217649US2XPCT	
---	--	--	--	--	--

24. The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) : <input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1040.00 <input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$890.00 <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$740.00 <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$710.00 <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 <p style="text-align: center;">ENTER APPROPRIATE BASIC FEE AMOUNT =</p>	CALCULATIONS PTO USE ONLY <table border="1" style="width:100%; border-collapse: collapse;"> <tr><td style="width:50%; height: 100px;"></td><td style="width:50%;"></td></tr> </table>			

Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).				\$0.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	16 - 20 =	0	x \$18.00	\$0.00	
Independent claims	3 - 3 =	0	x \$84.00	\$0.00	
Multiple Dependent Claims (check if applicable). <input checked="" type="checkbox"/>				\$280.00	
TOTAL OF ABOVE CALCULATIONS =				\$1,170.00	
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$0.00	
SUBTOTAL =				\$1,170.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).				\$0.00	
TOTAL NATIONAL FEE =				\$1,170.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). <input type="checkbox"/>				\$0.00	
TOTAL FEES ENCLOSED =				\$1,170.00	
				Amount to be: refunded	\$
				charged	\$

a. ☒ A check in the amount of **\$1,170.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

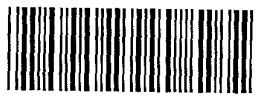
c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **15-0030**. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Surinder Sachar
Registration No. 34,423



22850

Surinder Sachar

SIGNATURE

Marvin J. Spivak

NAME

24,913

REGISTRATION NUMBER

Dec. 26 2001

DATE

12/ps/b

HYBRID CONSTRUCTION MACHINE AND CONTROL APPARATUS
THEREOF

TECHNICAL FIELD

The present invention relates to a hybrid construction machine such as a hybrid excavator for combining an engine and a battery to execute various works and a control apparatus thereof.

BACKGROUND OF THE INVENTION

In general, a construction machine such as an excavator is constructed such that a hydraulic pump is driven by means of an engine to drive an actuator with the hydraulic pressure, but with this construction, fuel efficiency thereof is poor and environmental problems such as noise, exhaust gas and the like occur, because works are executed while the engine output is largely varied correspondingly to large variation in load under work.

Therefore, in recent years, hybrid construction machines and control apparatuses thereof (Japanese Unexamined Utility Model Publication No. Hei 5-48501, Japanese Unexamined Patent Publication No. Hei 10-42587, etc.) have been developed and suggested, in which the engine is connected to an electric motor or a power generator to convert a part or whole of the engine output into electric power, power remaining in working with a light load is charged into a battery and the power is withdrawn from the battery to use in working with a heavy load. With this construction, for example, as shown in Fig.12, because varying part of work load (work energy) could be smoothed by means of charge and discharge of the battery, variation of the engine output could be suppressed as small as possible even when the work load (work energy) is largely varied, to thereby realize improvement of the fuel efficiency and reduction of noise and exhaust gas.

However, in the above conventional construction, because the electric

motor could not be driven when power could not be obtained from the power generator or the battery due to breakdown of the engine, the power generator, the battery and the like, operations after that time could not be executed. Therefore, for example, if the excavator is out of order when a boom is in a raised state, the boom stops in the raised position, the excavator must be left in this state until repair of the excavator is completed, and thus, safety could be threatened.

Also, the construction machine, specifically, the excavator is required to perform various works different in work load, such as excavating, making even, sloping a bank, scattering and the like. Therefore, unless a relationship among the kinds of works described above, the engine output and the charged state of the battery is considered, there occur problems such as waste of energy, deterioration of the battery, reduction of work efficiency and the like.

Therefore, a first object of the present invention is to provide a hybrid construction machine capable of assuring safety thereof by emergently driving electric motors when power cannot be obtained from a power generator or a battery due to breakdowns thereof.

A second object of the present invention is to provide a control apparatus of a hybrid construction machine capable of preventing deterioration of batteries due to excessive charge or discharge when executing various works different in load.

A third object of the present invention is to provide a control apparatus of a hybrid construction machine capable of suppressing reduction of work efficiency while preventing deterioration of batteries due to excessive discharge as small as possible.

SUMMARY OF THE INVENTION

The present invention provides a hybrid construction machine constructed to drive electric motors by means of power of a power generator

to be driven by an engine, power of a main battery and power of an auxiliary battery to be charged with the power of the power generator, comprising a switch for switching to drive the electric motors by means of normal power of at least one of the power generator and the main battery in a normal operation state and to drive the electric motors by means of auxiliary power of the auxiliary battery in an emergent operation state that the electric motor can not be driven by means of the normal power.

According to the above construction, because when the electric motors are not supplied with the normal power due to breakdowns of the power generator or the main battery in the normal operation, the electric motors can be driven by means of the auxiliary power from the auxiliary battery by switching to the auxiliary battery using the switch, to thereby execute the emergent operation, the construction machine can be moved in a safe region or restored in a safe pose to ensure safety and then parts out of order thereof can be repaired.

Also, the hybrid construction machine according to the present invention comprises an actuator-selecting switch for selecting the electric motors to be driven by means of the auxiliary power in the emergent operation. As a result, because only the electric motor selected by the actuator-selecting switch is driven by means of the auxiliary power, an auxiliary battery having a capacity smaller than that of the main battery required to drive many electric motors at the same time can be employed. Therefore, because the auxiliary battery can be minimized, enlargement of the construction machine due to equipment of the auxiliary battery can be suppressed as small as possible. Also, because undesired operations due to mis-manipulation and the like can be prevented, safety of the construction machine can be improved.

Also, the hybrid construction machine according to the present invention is a hybrid excavator. As a result, because the hybrid excavator assumes various poses such as the ascent of a boom or an arm and the like,

the present invention can be suitably employed in a state that the hybrid construction machine stops in such poses.

Also, the present invention provides a control apparatus of a hybrid construction machine for executing works by charging a battery with power of a power generator to be driven by an engine and then driving electric motors by means of power discharged from at least the battery, the control apparatus comprising a generator output control unit for varying power output from the power generator in accordance with content of work.

According to the above construction, because power output from the power generator can be varied in accordance with the content of work, large power can be output from the power generator in working with a large load and small power can be output from the power generator in working with a small load. Also, because work load is proportional to the power consumption of the electric motors, large power is discharged from the battery in working with a large load and small power is discharged from the battery in working with a small load. Therefore, power discharged from the battery is increased or decreased correspondingly to the load in working with a predetermined content of work, power output from the power generator is increased or decreased correspondingly to the load and thus, the amount of charge in the battery is increased or decreased, so that the battery should not be deteriorated due to excessive charge or excessive discharge thereof.

Also, the control apparatus according to the present invention comprises a manipulating lever to be manipulated by an operator, and a work determination unit for determining the content of work on the basis of manipulating signal from the manipulating lever and outputting the content of work to the generator output control unit. As a result, because the content of work can be determined and recognized on the basis of the manipulating signal of the manipulating lever, labor that the operator appoints the content of work can be omitted.

Also, the control apparatus according to the present invention comprises a work mode switch with which the content of work can be appointed by an operator, and a switch detection unit for detecting the content of work appointed with the work mode switch and outputting the content of work to the generator output control unit. As a result, because the content of work appointed with the work mode switch can be recognized with high reliability, excessive charge and discharge of the battery due to mis-recognition and the like can be surely prevented.

Also, the present invention provides a control apparatus of a hybrid construction machine for executing works by charging a battery with power of a power generator to be driven by an engine and driving electric motors by means of power of at least one of the power generator and the battery, comprising a work speed regulation unit for regulating work speed in accordance with content of work when the power of the power generator is a predetermined value or less, so that power consumption of the electric motors is in a range not to cause excessive discharge of the power generator.

According to the above construction, when power of the power generator to be driven by the engine is a predetermined value or less such as in a state that the engine stops or in an idling state, a predetermined time delay occurs until the engine is driven sufficiently to obtain sufficient power from the power generator. During the delayed time, each work in the content of work is executed using power discharged from the battery. Therefore, in working with a large work load, executing the work at normal work speed causes deterioration of the battery due to excessive discharge, but according to the above construction of the present invention, because the work speed regulating unit regulates the work speed in accordance with the content of work such that the excessive discharge of the battery can be prevented, the battery can not be deteriorated due to the excessive discharge.

Also, because the work speed is regulated in accordance with the content of work so that power consumption of the electric motors is in a range not to cause the excessive discharge, the work speed of the respective contents of work can be set up to a maximum value in a range not to cause the excessive discharge. Therefore, because in working with a small work load, the work can be executed at a speed substantially equal to the normal work speed, work efficiency greater than that in the conventional case that the work speed is kept constant regardless of the content of work can be improved, to thereby suppress reduction of the work efficiency due to regulation of the work speed as small as possible.

Also, the control apparatus according to the present invention comprises a manipulating lever to be manipulated by an operator, and a work determination unit for determining the content of work on the basis of manipulating signal from the manipulating lever and outputting the result to the work speed regulation unit. As a result, because the content of work can be determined and recognized on the basis of the manipulating signal from the manipulating lever, labor that an operator appoints the content of work can be obviated.

Also, the control apparatus according to the present invention comprises a work mode switch with which the content of work can be appointed by an operator, and a switch detection unit for detecting the content of work appointed with the work mode switch and outputting the result to the work speed regulation unit. As a result, because the content of work appointed with the work mode switch can be recognized with high reliability, excessive discharge of the main battery due to mis-recognition can be surely prevented.

Also, the hybrid construction machine including the control apparatus according to the present invention is a hybrid excavator. As a result, the present invention can be suitably applied to a hybrid excavator

for executing various contents of work of which load is varied within a great range.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 is a block diagram showing a control apparatus of the hybrid excavator;

Fig.2 is a flow chart showing a selection routine of an actuator;

Fig.3 is a side view schematically showing the whole hybrid excavator;

Fig.4 is a block diagram showing a control apparatus of the hybrid excavator;

Fig.5 is a flow chart showing an output variation routine;

Fig.6 is an explanatory view showing load properties of the respective works;

Fig.7 is an explanatory view showing a relationship between the working mode and the generator output;

Fig.8 is a block diagram showing a driving control system of the hybrid excavator;

Fig.9 is a block diagram showing a control apparatus of the hybrid excavator;

Fig.10 is a flow chart showing a correcting routine of manipulating signal;

Fig.11 is a block diagram showing a driving control system of the hybrid excavator; and

Fig.12 is an explanatory view showing charging and discharging states of a battery in working in a hybrid mode.

PREFERRED EMBODIMENT OF THE INVENTION

(FIRST EMBODIMENT)

Now, a first embodiment of the present invention will be explained with reference to Figs.1 to 3. Also, although in the following description, a hybrid excavator employing a series type hybrid mode will be explained, the first embodiment of the present invention may be applied to a hybrid excavator employing a parallel type hybrid mode.

The hybrid excavator which is a hybrid construction machine according to the first embodiment, as shown in Fig.3, includes a lower traveling body 1, an upper rotating body 2 rotationally provided at upper center of the lower traveling body 1, and an excavating attachment 3 provided at front part of the upper rotating body 2. The lower traveling body 1 has a pair of crawler frames 4 arranged at both ends thereof in parallel to each other, crawlers 5 rotationally provided around the respective crawler frames 4 and in surface contact with the ground, electric motors 6, 7 and reduction gears 35, 36 for rotationally driving the crawlers 5. The lower traveling body 1 constructed like this drives rotationally and separately the respective crawlers 5 in forward and backward directions through the reduction gears 35, 36 by means of the electric motors 6, 7 so that the whole excavator can advance, retreat, rotate and revolve.

At upper center of the lower traveling body 1, a rotating shaft 8a is provided perpendicular to the lower traveling body 1. In upper portion of the rotating shaft 8a, a rotating frame 8 constructing a part of the upper rotating body 2 is rotationally provided. On upper surface of the rotating frame 8, a cabin 9 to be an operating room for an operator and a machinery-receiving unit 41 covered with a protective cover 40 are provided and also, a boom 17 of the excavating attachment 3 and one end of a boom cylinder 18 are provided to be pivotable vertically.

Within the machinery-receiving unit 41, a rotating electric motor 13 and a reduction gear 14 are provided and also, an integral type boom actuator A1 including a boom electric motor 15 and a boom pump 16 as one body is provided. The rotating electric motor 13 drives the rotating frame 8

through the reduction gear 14 to revolve around the rotating shaft 8a. Also, the integral type boom actuator A1 is connected through hydraulic pipe not shown to the boom cylinder 18 and make a cylinder rod of the boom cylinder 18 advance and retreat with hydraulic pressure, to thereby make move up and down a front end (the other end) side of the boom 17.

At the front end of the boom 17, an arm 19 is rotationally provided. At the front end of the arm 19, a bucket 21 is rotationally provided. Also, the boom 17 and the arm 19 are connected through an arm cylinder 20 to each other, and the arm 19 and the bucket 21 are connected through a bucket cylinder 22 to each other. At these cylinders 20, 22, an integral type arm actuator A2 and an integral type bucket actuator A3 are provided, respectively, and electric motors 23, 25 and pumps 24, 26 are incorporated as one body to construct the respective actuators A2, A3. The respective actuators A2, A3 make cylinder rods of the cylinders 20, 22 move forward and backward by the hydraulic pressure and thus, the arm 19 and the bucket 21 pivot up and down, respectively.

Also, in the above machinery-receiving body 41, an engine 10, a power generator 11 for generating AC power corresponding to rotational speed (output of engine) of the engine 10, a main battery 12 used in normal operation and an auxiliary battery 42 used in emergent operation in which the main battery 12 cannot be used are provided, in addition to the rotating electric motor 13 and the integral type boom actuator A1. Also, a secondary battery capable of repeatedly being charged with and discharging power such as a Pb storage battery or nickel hydrogen storage battery is employed in both of the batteries 12, 42.

As shown in Fig.1, the power generator 11 is connected to a motor controller 37 of the control apparatus. The motor controller 37 is connected to the various electric motors 6, 7, 13, 15, 23, 25 described above and connected through a switch 43 to the main battery 12 and the auxiliary battery 42. The switch 43 comprises 3 switching parts 43a~43c for bi-

directionally switching, wherein two switching parts 43a, 43b are used for charging and stopping the main battery 12 and one switching part 43c remained is used for switching between discharge from the main battery 12 and discharge from the auxiliary battery 42. The switch 43 is set up such that at the time of normal operation, the switching parts 43a~43c all connect the main battery 12 and the motor controller 37 to each other and such that at the time of emergent operation, the switching parts 43a, 43b are separated from the main battery 12 and the switching part 43c is switched to connect the auxiliary battery 42 and the motor controller 37 to each other. Also, switching manipulation of the switch 43 may be executed manually by an operator and may be executed automatically when defect such as a drop in electric power is detected.

The motor controller 37 described above has various control functions such as a function of a power converter (a function of an inverter) for converting AC power from the power generator 11 into DC power or converting DC power from the battery 12, 42 into AC power, a function of driving the electric motors for outputting AC power obtained by means of conversion from, for example, the main battery 12 to the respective electric motors 6, 7, 13, 15, 23, 25 on the basis of manipulating signal from a manipulating lever 45, a function of normal charge for charging the main battery 12 with power generated from the power generator 11 and a function of revival charge for charging the main battery 12 with revival power generated from the respective electric motors 6, 7, 13, 15, 23, 25, and also, has a function for detecting amount of charge in the main battery 12, amount of generation in the power generator and the like. Therefore, the control functions can be arbitrarily executed on the basis of amount of charge in the main battery 12, amount of generation in the power generator 11 and the like.

Also, the motor controller 37 has a battery-switching detection body 52 and an actuator-switching body 53. The switch 43 is connected to the

battery-switching detection body 52 and thus, the battery-switching detection body 52 detects connecting states of the respective switching parts 43a~43c in the switch 43 and outputs it to the actuator-switching body 53 as switching detection signal. Also, the actuator-switching body 53 is connected with the manipulating lever 45 and the actuator-selecting switch 54, in addition to the battery-switching detection body 52. The manipulating lever 45 and the actuator-selecting switch 54 are provided in the cabin 9 shown in Fig.3 and outputs the manipulating signal corresponding to amount of manipulation by the operator. Also, the actuator-selecting switch 54 is used in operator's appointing the electric motors that can be driven by means of power of the auxiliary battery 42.

As described above, the actuator-switching body 53 to which signal is input from the respective units 45, 52, 54 monitors the switching detection signal from the battery-switching detection body 52 while executing an actuator-selecting routine, makes all electric motors 6, 7, 13, 15, 23, 25 operate when connection to the main battery 12 is recognized, and makes only the specific electric motors selected by the actuator-selecting switch 54 operate when connection to the auxiliary battery 42 is recognized, on the basis of the signal.

In the above construction, operation of the hybrid excavator will be explained hereinafter.

When power is input to the motor controller 37 and the engine 10 is driven, by executing starting manipulation such that the operator in the cabin shown in Fig.3 has the operating key turned, the motor controller 37 first recognizes amount of charge in the main battery 12. If the amount of charge is insufficient, AC power generated from the power generator to be driven by the engine 10 is converted into DC power to charge the main battery 12. Also, if the amount of charge is excessively insufficient, output (rotational speed) of the engine 10 is increased and thus, the amount of generation from the power generator 12 is increased, to promptly charge the

main battery 12. On the other hand, if the amount of charge is sufficient, the output (rotational speed) of the engine 10 is in an idling state in which the output is minimum or the engine 10 is made to stop, to thereby prevent excessive charge of the main battery 12 and then, to stand by until manipulating signal is input from the manipulating lever 45.

Next, when the operator manipulates the manipulating lever 45 to execute a predetermined work, manipulating signal corresponding to amount of manipulation is output from the manipulating lever 45. The manipulating signal is input to the actuator-switching body 53 of the motor controller 37. At that time, the actuator-switching body 53 monitors connecting state (selecting state) of the switch 43 on the basis of switching detection signal from the battery-switching detection body 52 while executing an actuator-selecting routine of Fig.2 (S1). When connection to the main battery 12 is recognized (S1, YES), the respective electric motors 6, 7, 13, 15, 23, 25 are driven by manipulation amount corresponding to the manipulating signal from the manipulating lever 45, so that the content of work is executed using the normal power from the main battery 12 or the power generator 11 (S2).

Next, when the normal power cannot be supplied to the electric motors 6, 7, 13, 15, 23, 25 due to breakdown of the engine 10, the power generator 11, the main battery 12 and the like under work, the boom 17 or the arm 19 of Fig.3 stops in the course of working. For example, when the boom stops in a pose pivoted upward, the boom 17 can suddenly go down by its own weight in repairing wrong parts and thus, workers may lay in very dangerous situation. Also, when the excavator stopped on a slope, workers handles with repairing apparatuses in a sloped state that balance of the excavator is not good and thus, the workers may have a heavy burden.

Accordingly, an operator switches connection of a switch 43 from the main battery to the auxiliary battery in stopping under work, so that auxiliary power of the auxiliary battery can be supplied to the respective

electric motors 6, 7, 13, 15, 23, 25 via a motor controller 37. When connection of the switch 43 is switched, the battery-switching detection body 52 for detecting connection thereof outputs the switching detection signal to an actuator-switching body 53. If the actuator-switching body 53 recognizes connection to the auxiliary battery on the basis of the detection signal (S1, NO), selection signal is introduced from the actuator-selecting switch 54 and it is determined whether operation of a boom 17 is selected or not on the basis of the selection signal of the actuator-selecting switch 54(S3). For example, in a case that the boom 17 stops in a pose pivoted upward, if an operator selects "boom selection" in the actuator-selecting switch 54, it is determined that the boom 17 is selected (S3, YES) and only the electric motor 15 for boom is driven by means of power from the auxiliary battery 42 (S4). Thus, the operator can manipulate a manipulating lever 45 to get the boom 17 down to a safe position, and even if the operator makes a mistake in manipulating, there is no case that undesired operation is caused in the excavator.

Also, when the boom 17 is not selected (S3, NO), it is determined whether the arm 19 is selected or not (S5). If the arm 19 is selected (S5, YES), only the electric motor 23 for arm is driven (S6), and if the arm 19 is not selected (S5, NO), it is determined whether the bucket 21 is selected or not (S7). If the bucket 21 is selected (S7, YES), only the electric motor for bucket 25 is driven (S8), and if the bucket 21 is not selected (S7, NO), it is determined whether rotating operation is selected or not (S9). If the rotating operation is selected (S9, YES), only the electric motor for rotating operation 13 is driven (S10) and if the rotating operation is not selected (S9, NO), it is determined whether traveling operation is selected or not (S11). If the traveling operation is selected (S11, YES), only the electric motor 6 for left-traveling and the electric motor 7 for right-traveling are driven (S12).

Only the electric motors 6, 7, 13, 15, 23, 25 selected like above are driven and thus, after the excavator is moved into a safe region or in a safe

pose, detection or repair of parts out of order can be executed. If repairing is over, the switch 43 is switched to connection to the main battery 12, and thus, the electric motors 6, 7, 13, 15, 23, 25 all can be driven with normal power, to execute works normally.

As described above, the hybrid excavator is constructed to drive the electric motor 15 by means of power of the power generator 11 to be driven by the engine 10, power of the auxiliary battery 42 and power of the main battery 12 to be charged with power of the generator 11. The hybrid excavator comprises a switch 43 for switching to drive the electric motor 15 by means of normal power of at least one of the power generator 11 and the main battery 12 in normal operation and to drive the electric motor 15 by means of auxiliary power of the auxiliary battery 42.

According to the above construction, because when normal power is not supplied to the electric motor 15 due to breakdown of the power generator 11, the main battery 12 and the like in the normal operation, the auxiliary battery 42 is connected by the switch 43 so that the electric motor 15 and the like can be driven by means of auxiliary power from the auxiliary battery 42, the construction machine is moved in a safe region or restored in a safe pose and then, parts out of order can be repaired.

Also, the hybrid excavator has an actuator-selecting switch 54 for selecting the electric motor 15 to be driven by means of the auxiliary power in the emergent operation. Since only the electric motor 15 selected by the actuator-selecting switch 54 can be driven by means of the auxiliary power, an auxiliary battery having capacity smaller than that of the main battery to drive many electric motors 15 and the like at the same time can be employed. Therefore, because the auxiliary battery 42 can be minimized, enlargement of the excavator due to addition of the auxiliary battery can be suppressed as much as possible. Also, it is possible to improve safety by preventing undesired operation due to mistake of manipulation.

Further, although the construction of the present embodiment and constructions of a second embodiment and a third embodiment to be described later can be properly applied to a hybrid excavator for assuming various poses such as rising of the boom 17 or the arm 19, the present invention is not limited to that and can be employed in all hybrid construction machines such as a bulldozer or a crane.

(SECOND EMBODIMENT)

Now, a second embodiment of the present invention will be explained with reference to Figs.3 to 8. Also, the same reference numeral is attached to the same element as that of the first embodiment and the explanation thereof will be omitted.

The hybrid excavator that is a hybrid construction machine according to the present invention comprises the motor controller 37, as shown in Fig.4. The motor controller 37 is connected to a manipulating lever 45 provided in the cabin 9 of Fig.3. The manipulating lever 45 is connected to a work determination body 46 together with the motor controller 37 and the work determination body 46 determines work mode on the basis of a manipulating signal from the manipulating lever 45.

The work determination body 46 is connected to a generator output control body 51 constructing a part of the control apparatus and by executing an output varying routine of Fig.5, the generator output control body 51 controls rotational speed of the engine 10 by means of governor control and the like such that output of the power generator 11 corresponds to work mode. Also, the generator output control body 51 may control the power generator 11, instead of the engine 10, by means of field magnet current control and the like. The power generator 11 for outputting power corresponding to work mode is connected to the motor controller 37 in the work determination body 46. The construction except for the above construction is equal to that of the first embodiment.

In the above construction, operation of the hybrid excavator will be explained hereinafter.

When power is input to the motor controller 37 and the engine 10 is driven, by executing starting manipulation such that the operator in the cabin of Fig.3 has the operating key turned, the motor controller 37 first recognizes amount of charge in the main battery 12. If the amount of charge is insufficient, AC power generated from the power generator 11 to be driven by the engine 10 is converted into DC power to charge the main battery 12. Also, if the amount of charge is excessively insufficient, output (rotational speed) of the engine 10 is increased and thus, the amount of generation from the power generator 12 is increased, to promptly charge the main battery 12. On the other hand, if the amount of charge into the main battery 12 is sufficient, the output (rotational speed) of the engine 10 is in an idling state in which the output is minimum or the engine 10 is made to stop, to thereby prevent the excessive charge of the main battery 12 and then, to stand by until manipulating signal is input from the manipulating lever 45.

Next, when the operator manipulates the manipulating lever 45 to execute a predetermined work, the manipulating signal corresponding to amount of manipulation is output from the manipulating lever 45. The manipulating signal is input to the motor controller 37 and the work determination body 46, respectively. In the motor controller 37, its operation is started by using power discharged from the main battery 12 to drive the electric motor 6, 7, 13, 15, 23, 25, respectively with the manipulating mount corresponding to the manipulating signal. The work determination body 46 extracts feature of the manipulating signal and determines the work mode. As a method for determining work mode, for example, the method disclosed in Japanese Unexamined Patent Publication No. Hei 9-217702 can be used.

The work mode recognized by the work determination body 46 like above is output to the generator output control body 51. At that time, the generator output control body 47, while executing an output varying routine as shown in Fig.5, receives a work mode signal from the work determination body 46 in order to recognize the work mode (content of work) included in the work mode signal (S21). As shown in Fig. 7, if the work mode is recognized, an output data of the power generator 11 corresponding to the recognized work mode is selected from the relation between the work mode stored in a memory and the output of the power generator 11. For example, when "scattering" is recognized as work mode, the output data of 4kW set up correspondingly to the work mode is selected, and when "pushing excavation" is recognized as work mode, the output data of 20kW set up correspondingly to the work mode is selected.

Then, rotational speed of the engine 10 corresponding to the selected output data is calculated, and the engine 10 is controlled to be at the rotational speed (S23). For example, when "scattering" is carried out as work mode, power 4kW generated from the power generator 11 is small relatively, but since the work mode of "scattering" has light load and amount of generation of the main battery 12 is very small, it can be charged effectively without excessive charge. Also, when "pushing excavation" is carried out as work mode, power 20kW generated from the power generator 11 is large relatively, but since the work mode of "pushing excavation" has heavy load and amount of discharge from the main battery 12 is very large, it can be charged effectively without excessive discharge.

Then, by monitoring work mode signal, manipulating signal and the like, it is determined whether work is over or not (S24). If work is not over (S24, NO), the engine 10 is controlled to maintain output of the power generator 11 selected correspondingly to the work mode described above. If work is over (S24, YES), operations are executed again from the step S21 so that control corresponding to next work mode can be carried out.

As described above, the hybrid excavator is constructed to charge the main battery 12 with power of the power generator 11 to be driven by the engine 10 as shown in Fig. 4 and comprises a control apparatus which can execute works by driving the electric motor 6 and the like with power discharged at least from the main battery 12. The control apparatus is constructed to have the generator output control body 51 for varying power output from the power generator 11 correspondingly to work load in the work mode (content of work).

According to the construction described above, if power output from the power generator 11 is varied correspondingly to work load of the work mode, large power is output from the power generator 11 when the work load is large, and small power is output from the power generator 11 when the work load is small. Also, since the work load is proportional to power consumption of the electric motor 6 and the like, large power is output from the main battery 12 when the work load is large, and small power is output from the main battery 12 when the work load is small. Thus, when work is progressed in predetermined work mode and power output from the main battery 12 is increased and decreased correspondingly to the work load, power output from the power generator 11 is increased and decreased correspondingly to the work load, and thus, amount of charge of the main battery 12 is increased and decreased. Therefore, it is sure that the main battery 12 cannot be deteriorated due to excessive charge or discharge.

Also, the above control apparatus is constructed to have a manipulating lever 45 to be manipulated by an operator and a work determination body 46 for determining work mode (content of work) and outputting the work mode to the generator output control body 51 on the basis of a manipulation signal from the manipulation lever 45. According to this construction, since work mode can be determined and recognized on the basis of the manipulating signal of the manipulating lever 45, labor that an operator appoints work mode can be reduced.

Also, although in the control apparatus according to the present embodiment, the work determination body 46 recognizes the work mode on the basis of manipulating signal of the manipulation lever 45, the present invention is not limited to this example. In other words, as shown in Fig. 8, the control apparatus may be constructed to have a work mode switch 49 with which work mode can be appointed by an operator and a switch detection body 50 for detecting the work mode (content of work) appointed with the work mode switch 49 and outputting the work mode to the generator output control body 51. Also, according to this construction, since work mode appointed with the work mode switch 49 can be recognized with high reliability, it is possible to prevent excessive charge or discharge of the main battery 12 due to mis-recognition(wrong recognition).

(THIRD EMBODIMENT)

Now, a third embodiment of the present invention will be explained with reference to Fig.3, Fig.6 and Figs.9 to 11. Also, the same reference numeral is attached to the same element as that of the first embodiment and the explanation thereof will be omitted.

The hybrid excavator that is a hybrid construction machine according to the present embodiment comprises the motor controller 37, as shown in Fig.9. The motor controller 37 is connected with a manipulating signal system 44 constructing a part of the control apparatus. The manipulating signal system 44 has a manipulating lever 45 provided in the cabin 9 of Fig.3, a work determination body 46 for determining work mode (content of work) on the basis of a manipulating signal from the manipulating lever 45 and a work speed regulation body 47.

The work speed regulation body 47 is connected to the manipulating lever 45 and the work determination body 46 and connected to a power detection body 48 for detecting power consumption of the electric motors 6, 7, 13, 15, 23, 25. The work speed regulation body 47 executes a manipulating signal-correcting routine of Fig.10, and outputs the manipulating signal

correspondingly to the work mode under a predetermined condition to prevent the excessive discharge of the main battery 12 while regulating it, on the basis of the manipulating signal, the work mode signal, the power consumption signal and the like input from the respective bodies 45, 46, 48. Also, the work speed regulation body 47 receives the generation-amount detecting signal of the power generator 11 from the motor controller 37. The construction except for the above construction is equal to that of the first embodiment.

In the above construction, operation of the hybrid excavator will be explained hereinafter.

When power is input to the motor controller 37 and the engine 10 is driven, by executing starting manipulation such that the operator in the cabin of Fig.3 has the operating key turned, the motor controller 37 first recognizes amount of charge in the main battery 12. If the amount of charge is insufficient, AC power generated from the power generator to be driven by the engine 10 is converted into DC power to charge the main battery 12. Also, if the amount of charge is excessively insufficient, output (rotational speed) of the engine 10 is increased and thus, the amount of generation from the power generator 12 is increased, to promptly charge the main battery 12. On the other hand, if the amount of charge is sufficient, the output (rotational speed) of the engine 10 is in an idling state in which the output is minimum or the engine 10 is made to stop, and wait until manipulating signal is input from the manipulating signal system 44 while preventing the excessive charge of the main battery 12.

Next, when the operator manipulates the manipulating lever 45 to execute a predetermined work, the manipulating signal corresponding to amount of manipulation is output from the manipulating lever 45. The manipulating signal is input to the work determination body 46 and the work speed regulation body 47, respectively. The work determination body 46 extracts feature of the manipulating signal and determines the work

mode. As a method for determining the work mode, for example, the method disclosed in Japanese Unexamined Patent Publication No. Hei 9-217702 can be used.

The work mode recognized by the work determination body 46 like above is output to the work speed regulation body 47. At that time, the work speed regulation body 47, while executing a manipulating signal-correcting routine as shown in Fig.10, outputs the manipulating signal, as it is, to the motor controller 37 when the manipulating signal is input from the manipulating lever 45. By making the motor controller 37 in a standing by state operate the electric motors 6, 7, 13, 15, 23, 25 corresponding to the manipulating signal with the amount of manipulation of the manipulating signal, various works such as traveling of the excavator, excavating, sloping a bank and the like are executed (S31).

Thereafter, whether the engine 10 is in a stopping state or in an idling state is determined on the basis of, for example, generation amount of the power generator 11 (S32). When the engine 10 drives the power generator 11 at sufficient rotational speed (S32, NO), the works in all work mode can be executed without the work speed restricted, using large power from the power generator 11 and power from the main battery 12, and thus, S31 is re-executed to output the manipulating signal as it is to the motor controller 37 and to continue to work. On the other hand, when the engine 10 is in a stopping state or in a idling state (S32, YES), the power from the main battery 12 is mainly used until the engine 10 reaches a predetermined rotational speed. Accordingly, to prevent deterioration of the main battery 12 due to excessive discharge, operations following step S33 are executed.

That is, the power consumption of the electric motors 6, 7, 13, 15, 23, 25 is obtained through the power detection body 48 (S33) and sum of the power consumption is output(S34). A setting value previously set up to prevent the excessive discharge of the main battery 12 is compared with the sum value and whether the sum value is the setting value or more is

determined (S35). If the sum value is less than the setting value (S35, NO), it is determined that damage due to the excessive discharge of the main battery 12 does not occur even when works are continued by making the respective electric motors 6, 7, 13, 15, 23, 25 operate with the present manipulating signal. Accordingly, operations are re-executed from step S31 and works are continued at a work speed corresponding to the manipulating signal from the manipulating lever 45.

On the other hand, if the sum value of power consumption is the setting value or more (S35, YES), a work mode (content of work) input from the above work determination body 46 is introduced (S36) and regulating value corresponding to the work mode is selected. Also, because load variation or load level is different according to the work mode (content of work) as shown in Fig.6, the regulating value corresponding to the work mode is set up correspondingly to the respective work modes on the basis of reference amount of discharge not to deteriorate the main battery 12. For example, in a case of work mode that the load variation or load level is great such as traveling or excavating, the regulating value is set up such that the rotational speed (work speed) of the electric motors 6, 7, 13, 15, 23, 25 is decreased more largely than that in the normal operation. However, in a case of work mode that the load variation or load level is small such as hanging and the like, the regulating value is set up such that the rotational speed (work speed) of the electric motors 6, 7, 13, 15, 23, 25 is decreased a little smaller than that in the normal operation (S37).

If the regulating value corresponding to the work mode, as shown in Fig.9, the manipulating signal from the manipulating lever 45 is introduced (S38), the amount of regulation is corrected such that the regulating value is an upper limit, and then the manipulating signal is output to the motor controller 37 (S39). Accordingly, because work is executed at work speed (consumed power) of the regulating value even in manipulating the manipulating lever 45 to be at maximum speed, deterioration of the main

battery 12 due to the excessive discharge does not occur. Also, because the regulating values of the respective work modes are set up on the basis of the reference amount of discharge, works can be executed at work speed substantially equal to the normal work speed in case of work mode that load thereof is small. Therefore, reduction of work efficiency in the whole work can be suppressed as small as possible.

Next, whether restriction of the manipulating signal is continued or not is determined on the basis of the rotational speed of engine 10, amount of generation in the power generator 11 and the like (S40). When the engine 10 is driven at a sufficient rotational speed and works are executed without excessive discharge of the main battery 12 even if the work speed is not regulated with amount of generation in the power generator 11 and amount of discharge in the main battery 12, it is determined that regulation of the manipulating signal is completed (S40, NO). Then, S31 is re-executed and the manipulating signal is output to the motor controller 37, as it is, to execute the work at the normal work speed. On the other hand, when the rotational speed of the engine 10 or power from the main battery 12 is insufficient, it is determined that regulation of the manipulating signal is continued (S40, YES), and operations are re-executed from step S38 in order to prevent deterioration of the main battery 12 due to the excessive discharge. By outputting to the motor controller 37 while regulating and amount of manipulation, the work is continued at the regulated work speed.

As described above, the hybrid excavator comprises a control apparatus in which the main battery 12 can be charged with power of the power generator 11 to be driven by an engine 10 and the electric motor 6 operates by means of power of at least one of the power generator 11 and the main battery 12. The control apparatus has the work speed regulation body 47 for regulating the work speed correspondingly to the work mode (content of work) such that power consumption of the electric motor 6 should not cause discharge from the main battery 12 when power of the power

generator 11 is a predetermined value or less that causes discharge from the main battery 12.

According to the above construction, when the power of the power generator 11 to be driven by the engine 10 is the predetermined as in a state that the engine 10 stops or in an idling state, a predetermined time delay occurs until the engine 10 is sufficiently driven to obtain sufficient power from the power generator 11. During the delayed time, works are executed using the power discharged from the main battery 12. Therefore, in working with a large work load, executing the work at the normal work speed causes deterioration of the main battery 12 due to the excessive discharge, but according to the above construction of the present invention, because the work speed regulation body 47 regulates the work speed in accordance with the content of work so that the excessive discharge of the main battery 12 can be prevented, the main battery 12 can not be deteriorated due to the excessive discharge.

Also, because the work speed is regulated correspondingly to the content of work such that power consumption of the electric motor 6 is in a range not to cause the excessive discharge, the work speed of the respective contents of work can be set up to be a maximum value in a range not to cause the excessive discharge. Therefore, because in working with a small work load, the work can be executed at a speed substantially equal to the normal work speed, work efficiency greater than that in the conventional case that the work speed is regulated constant regardless of the content of work can be obtained, to thereby suppress decrease of the work efficiency due to regulation of the work speed as small as possible.

Also, the control apparatus according to the present invention comprises a manipulating lever 45 to be manipulated by an operator, and a work determination body 46 for determining the work mode (content of work) on the basis of manipulating signal from the manipulating lever 45. According to this construction, because the work mode can be determined

and recognized on the basis of the manipulating signal from the manipulating lever 45, labor that an operator appoints the content of work can be obviated.

Although, in the control apparatus of the present embodiment, the work mode is recognized on the manipulating signal from the manipulating lever 45 in the work determination body 46, the present invention is not limited to this construction. That is, the control apparatus, as shown in Fig.11, may have a work mode switch 49 by which an operator can appoint the content of work with, and a switch detection body 50 for detecting the work mode appointed with the work mode switch 49 and outputting the result to the work speed regulation body 47. In this case, because the work mode can be recognized with high reliability, the excessive discharge of the main battery 12 due to mis-recognition can be surely prevented.

Also, in the control apparatus of the present embodiment, S33, S34 and S35 in the flow chart of Fig.10 can be omitted. That is, when power from the power generator 11 is a predetermined value or less, a function for regulating speed correspondingly to the content of work in S36~S40 may be performed. In this construction, when the power from the power generator 11 is a predetermined value or less, the power consumption can be suppressed by means of regulation of speed corresponding to the content of work, and thus the excessive discharge of the battery can be prevented by properly regulating the work speed. Also, according to this construction, the power detection body 48 is not necessary and thus, the control system can be simplified

(INDUSTRIAL AVAILABILITY)

The control apparatus according to the present invention is suitably used in a hybrid construction machine required to assure the safety by driving emergently the electric motors when power cannot be obtained from the power generator or the battery due to breakdown and the like. Also, the control apparatus according to the present invention is suitably used in a

hybrid construction machine required, when executing various works different in load, to prevent deterioration of the battery due to the excessive charge or discharge, or to suppress reduction of work efficiency as small as possible while preventing deterioration of the battery due to the excessive discharge.

What is claimed is:

1. A hybrid construction machine constructed to drive electric motors (6, 7, 13, 15, 23, 25) by means of power of a power generator (11) to be driven by an engine (10), power of an auxiliary battery (42) and power of a main battery (12) to be charged with the power of the power generator (11), comprising:

a switch (43) for switching to drive the electric motors (6, 7, 13, 15, 23, 25) by means of normal power of at least one of the power generator (11) and the main battery (12) in a normal operation state and to drive the electric motors (6, 7, 13, 15, 23, 25) by means of auxiliary power of the auxiliary battery (42) in an emergent operation state that the electric motors (6, 7, 13, 15, 23, 25) can not be driven by means of the normal power.

2. The hybrid construction machine according to claim 1, further comprising an actuator-selecting switch (54) for selecting at least one of the electric motors (6, 7, 13, 15, 23, 25) to be driven by means of the auxiliary power in the emergent operation state.

3. The hybrid construction machine according to claim 1 or 2, wherein the hybrid construction machine is a hybrid excavator.

4. A control apparatus of a hybrid construction machine for executing works by charging a main battery (12) with power of a power generator (11) to be driven by an engine (10) and driving electric motors (6, 7, 13, 15, 23, 25) by means of power discharged from at least the main battery (12), comprising:

a generator output control body (51) for varying power output from the power generator (11) in accordance with content of work.

5. The control apparatus of a hybrid construction machine according to claim 4, further comprising:

a manipulating lever (45) to be manipulated by an operator; and

a work determination body (46) for determining the content of work on the basis of manipulating signal from the manipulating lever (45) and outputting the content of work to the generator output control body (51).

6. The control apparatus of a hybrid construction machine according to claim 4, further comprising:

a work mode switch (49) with which the content of work can be appointed by an operator; and

a switch detection body (50) for detecting the content of work appointed with the work mode switch (49) and outputting the content of work to the generator output control body (51).

7. A control apparatus of a hybrid construction machine for executing works by charging a main battery (12) with power of a power generator (11) to be driven by an engine (10) and driving electric motors (6, 7, 13, 15, 23, 25) by means of power of at least one of the power generator (11) and the main battery (12), comprising:

a work speed regulation body (47) for regulating work speed in accordance with content of work when power of the power generator (11) is a predetermined value or less.

8. The control apparatus of a hybrid construction machine according to claim 7, further comprising:

a manipulating lever (45) to be manipulated by an operator; and

a work determination body (46) for determining the content of work on the basis of manipulating signal from the manipulating lever (45) and outputting the content of work to the work speed regulation body (47).

9. The control apparatus of a hybrid construction machine according to claim 7, further comprising:

a work mode switch (49) with which the content of work can be appointed by an operator; and

a switch detection body (50) for detecting the content of work appointed with the work mode switch (49) and outputting the content of work to the work speed regulation body (47).

10. The control apparatus of a hybrid construction machine according to any of claims 4 to 9, wherein the hybrid construction machine is a hybrid excavator.

161

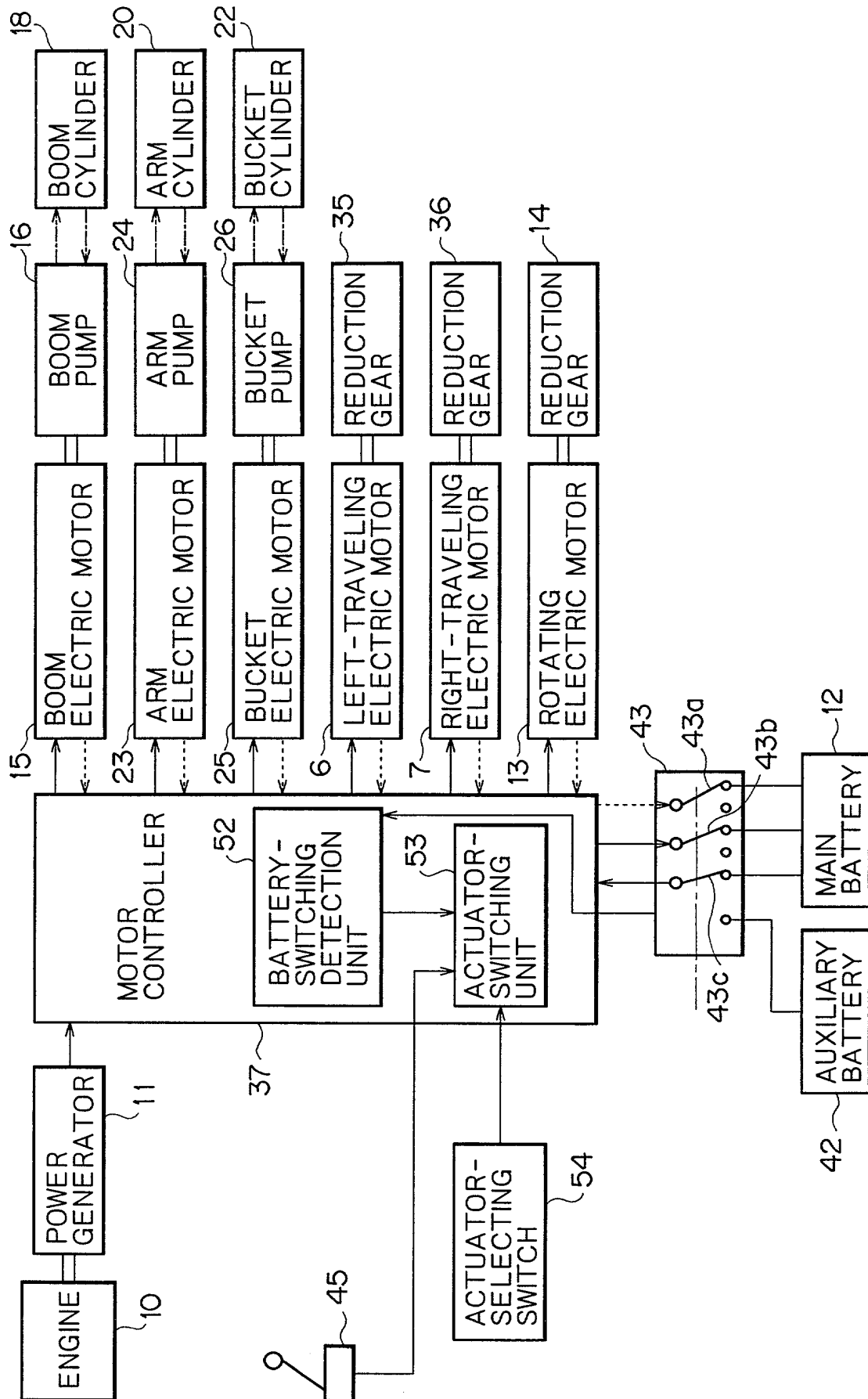


FIG. 2

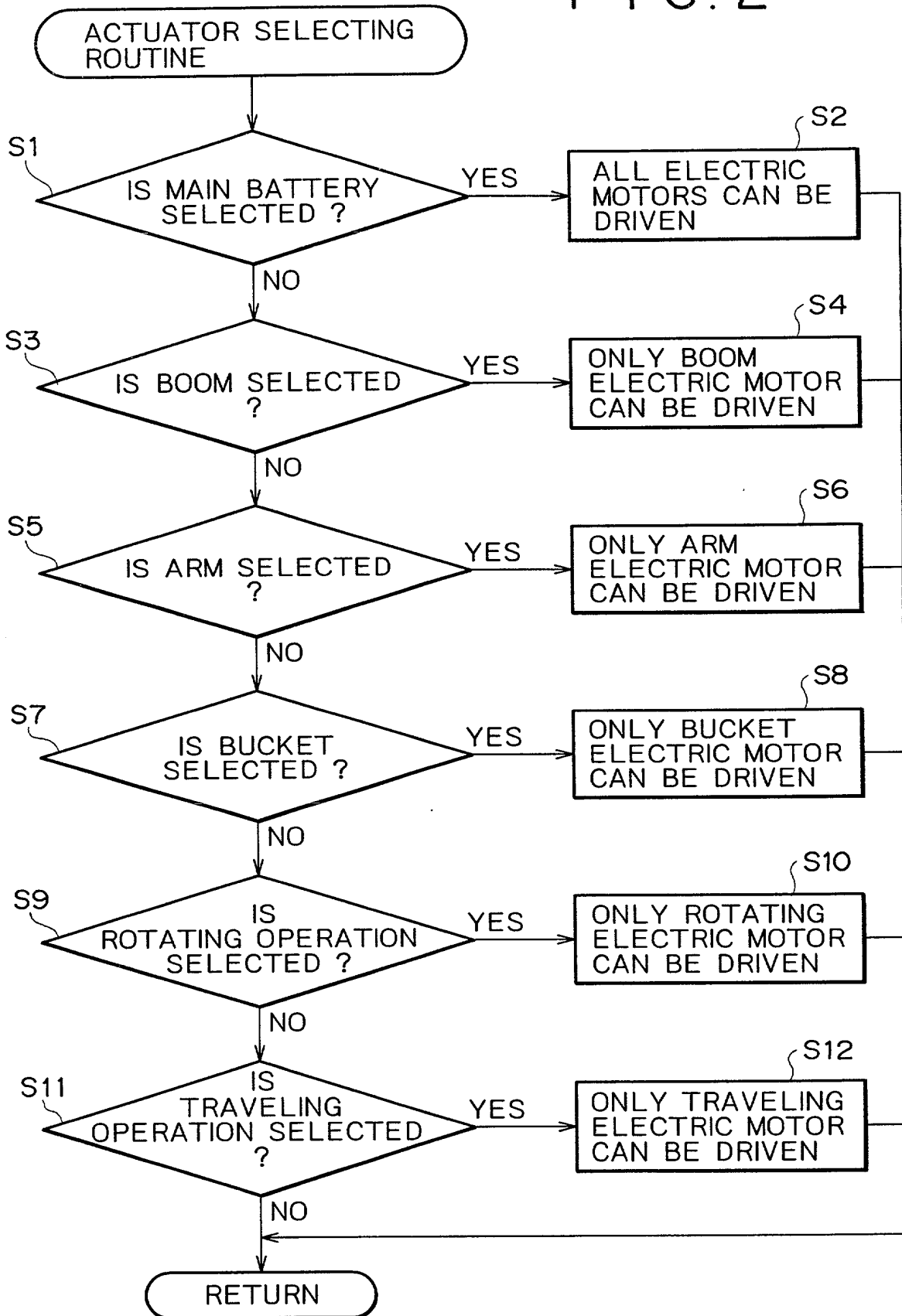


FIG. 3

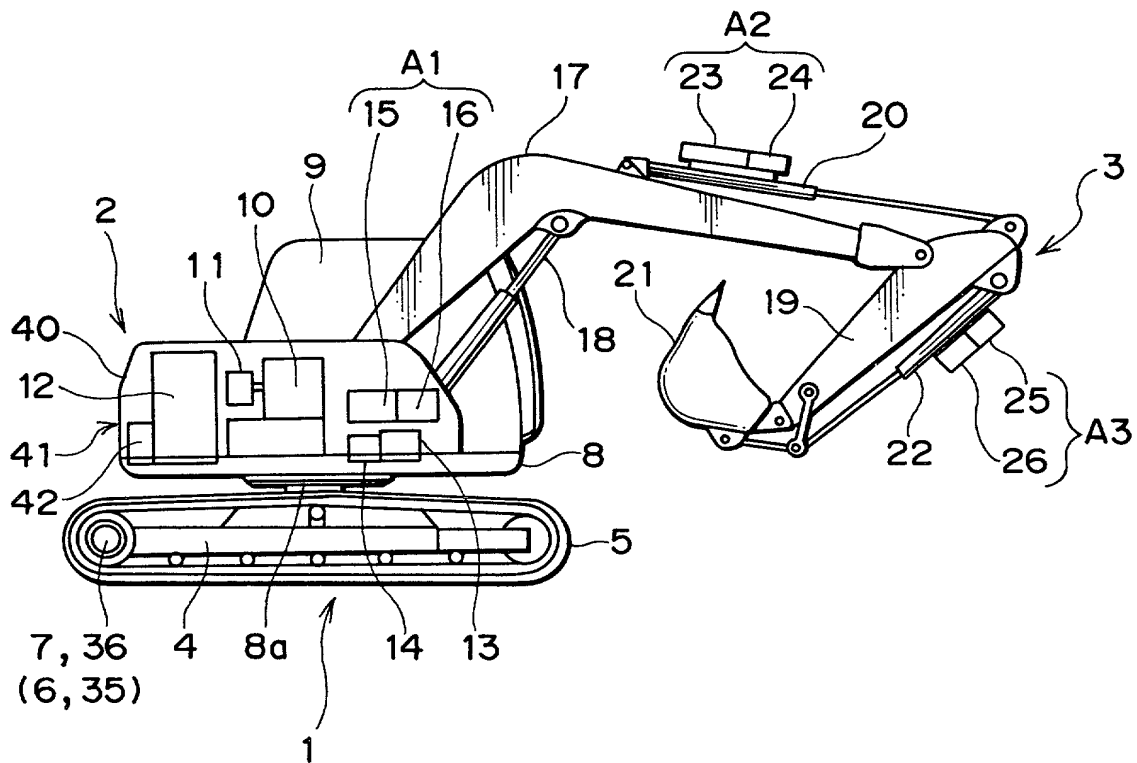


FIG. 4

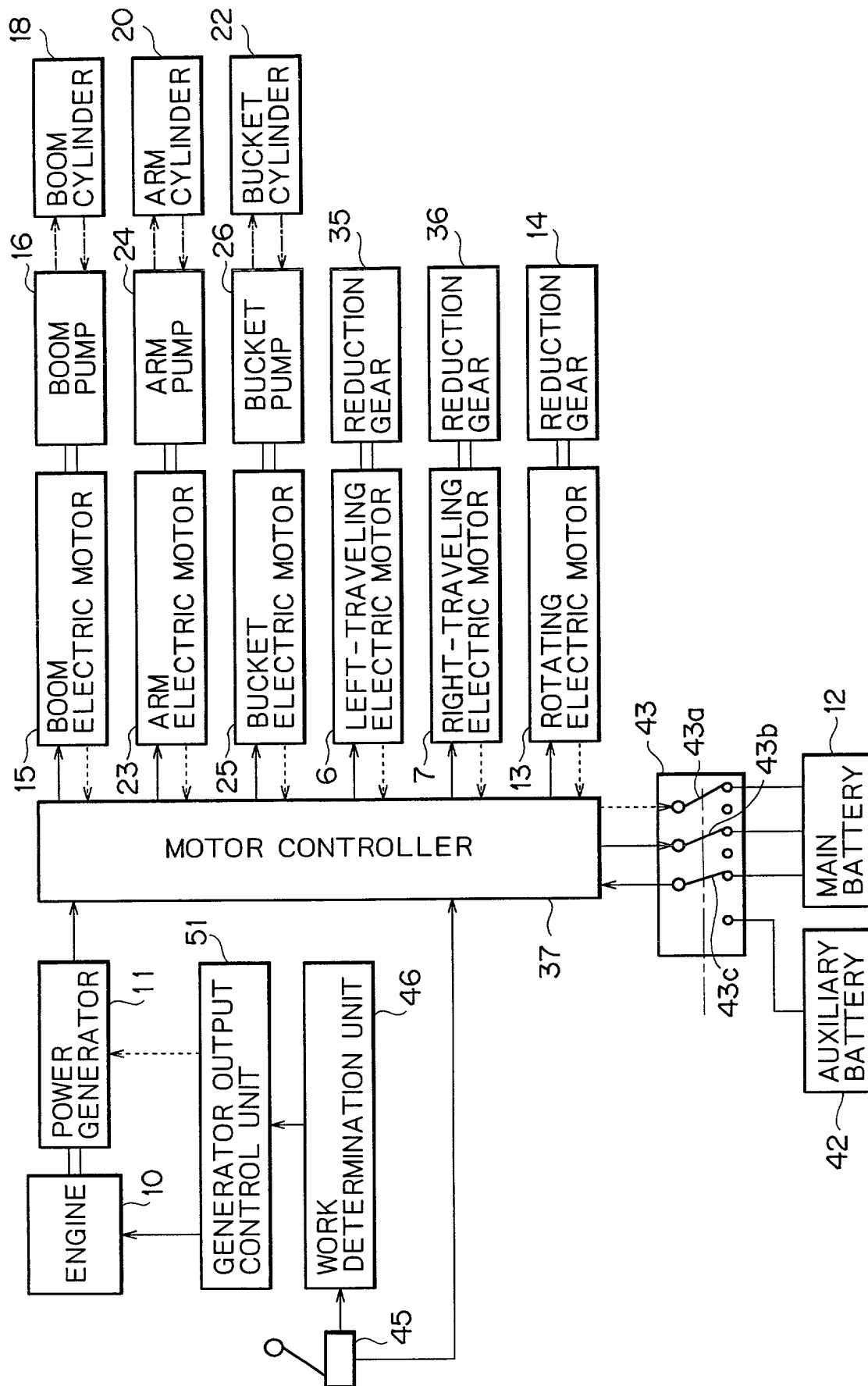


FIG. 5

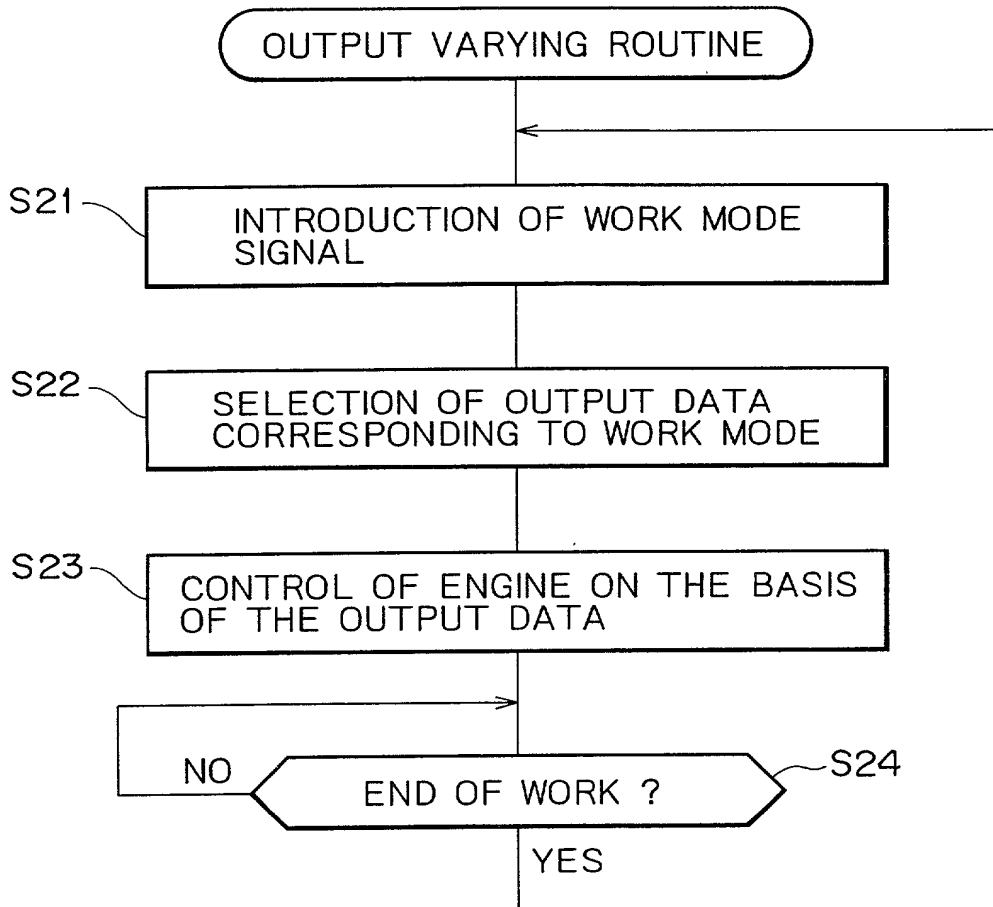


FIG. 6

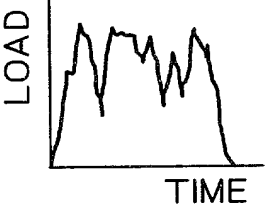
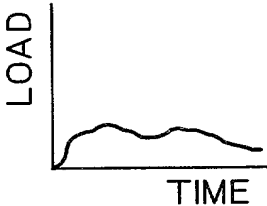
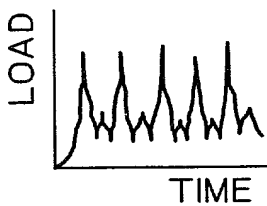
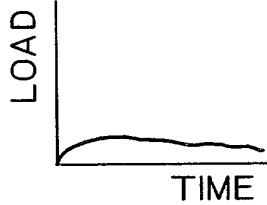
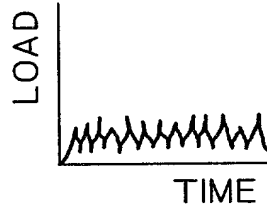
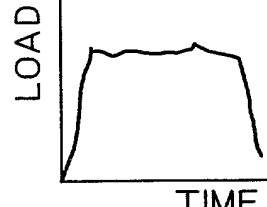
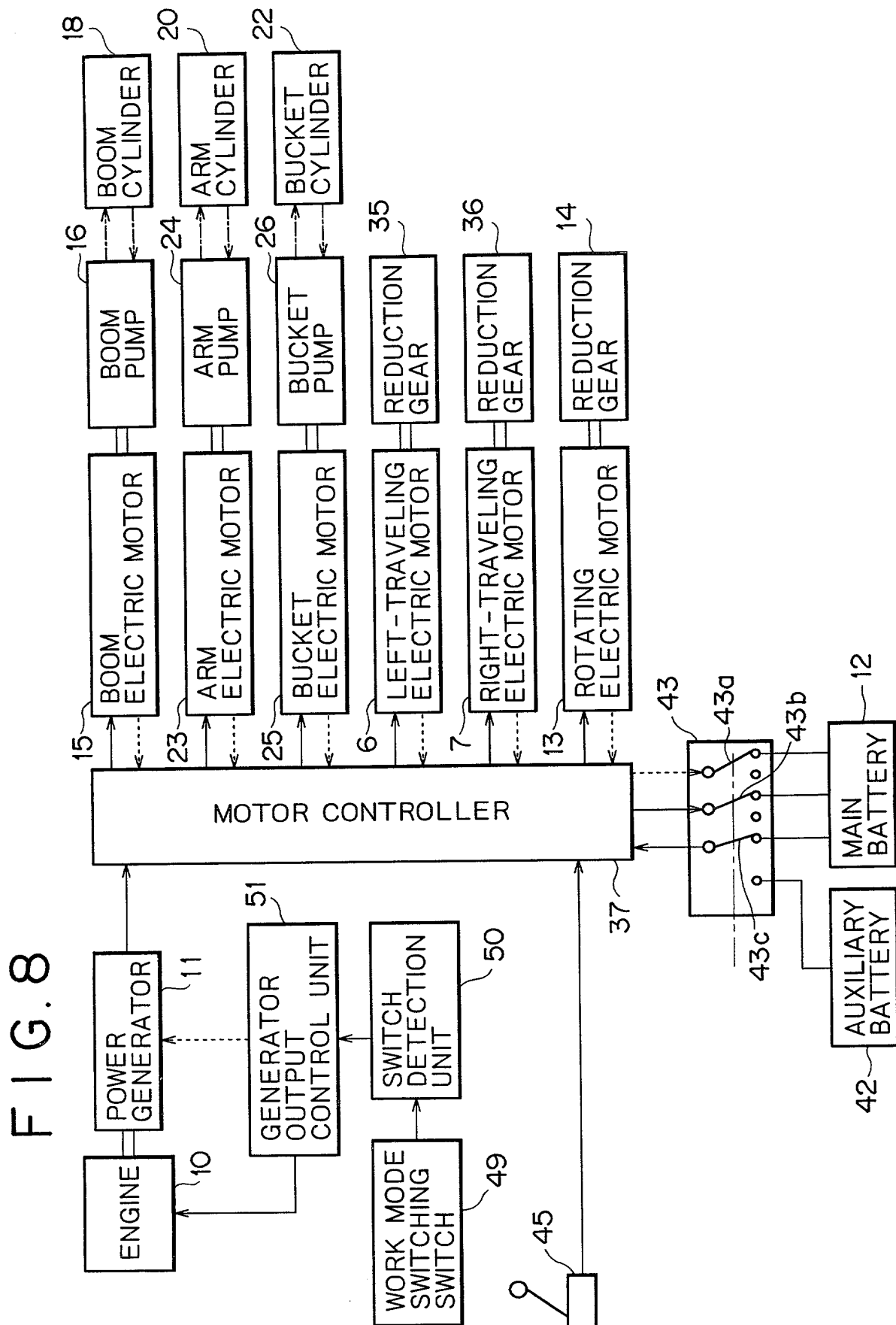
CONTENT OF WORK	LOAD PROPERTY	LOAD VARIATION	LOAD LEVEL
EXCAVATING		VERY RAPID AND LARGE VARIATION	HIGH
MAKING EVEN		RELATIVELY GENTLE	LOW
SLOPING A BANK		VERY RAPID AND LARGE VARIATION	MIDDLE
HANGING		GENTLE	LOW ~ MIDDLE (DIFFERENT ACCORDING TO HANGING LOAD)
SCATTERING		VERY RAPID AND SMALL VARIATION	LOW
TRAVELING		GENTLE	HIGH

FIG. 7

WORK MODE	OUTPUT OF POWER GENERATOR
SCATTERING	4 kW
SLOPING A BANK	5 kW
SLOPE LEVELING	9 kW
CRANE	6 kW
PUSHING EXCAVATING	20 kW
LOADING	6 kW
FLATTERING ROTATING PLACE	9 kW
SIMPLE EXCAVATING, GROOVE, HORIZONTAL EXCAVATING	20 kW



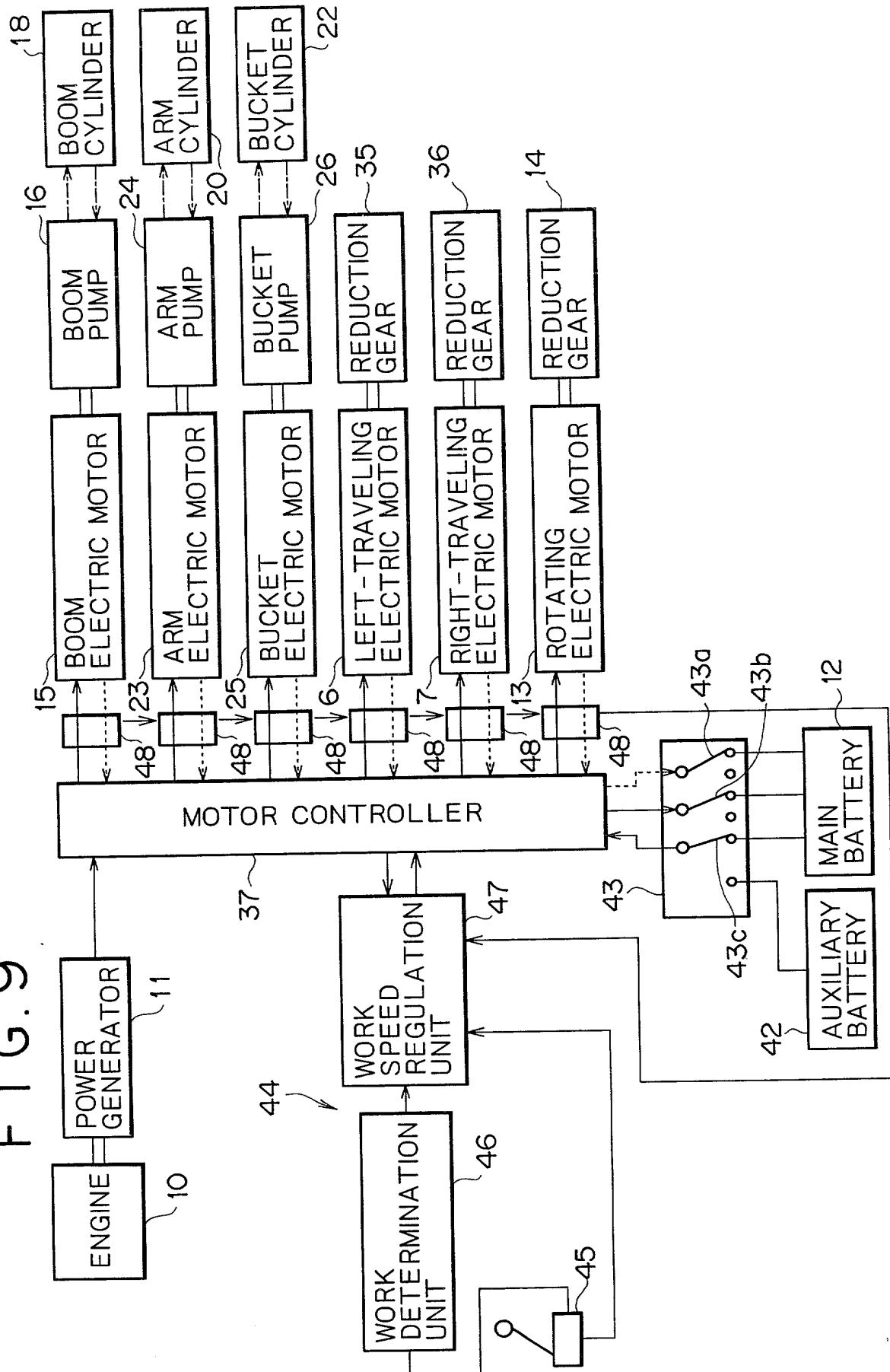


FIG. 10

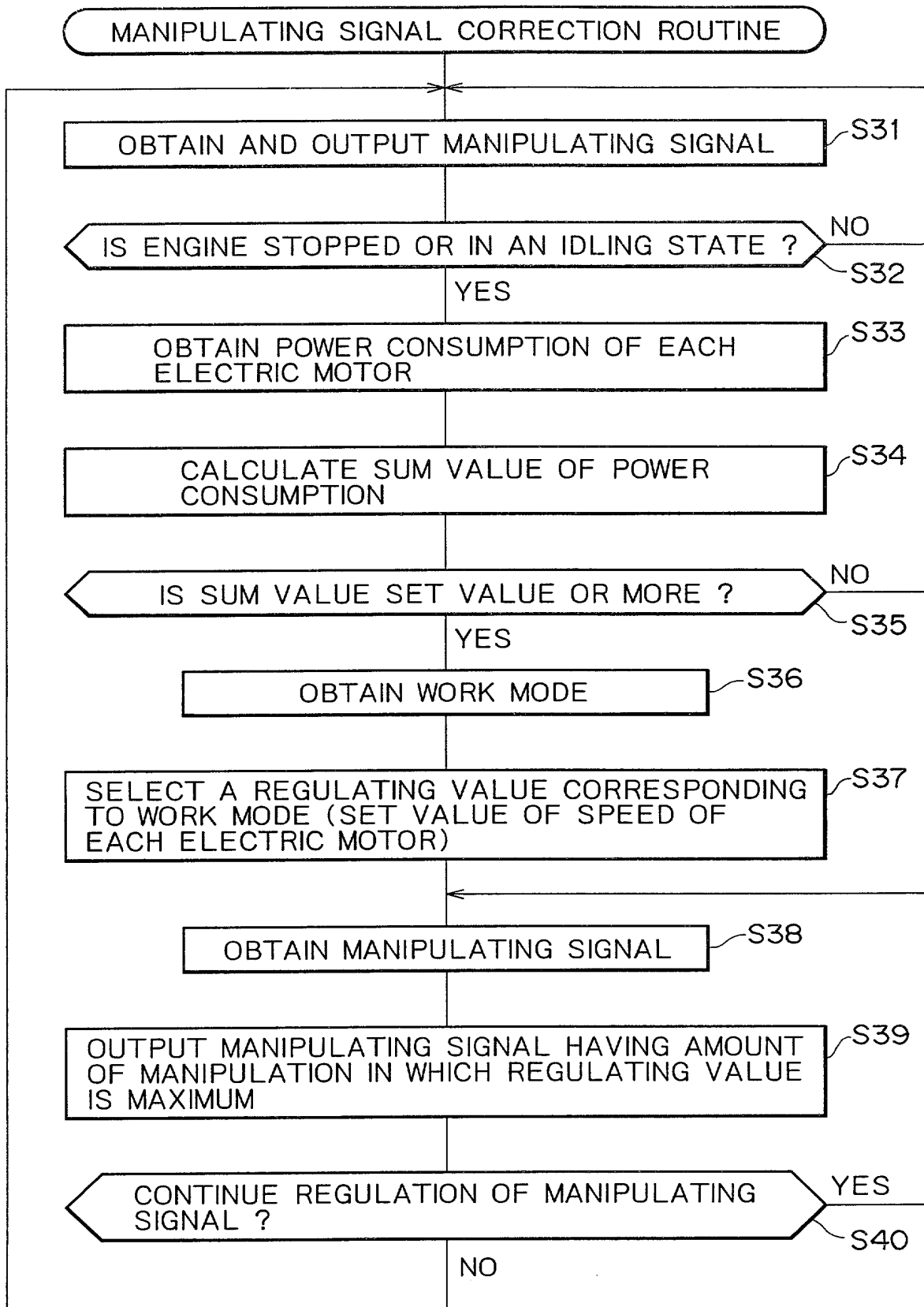


FIG. 11

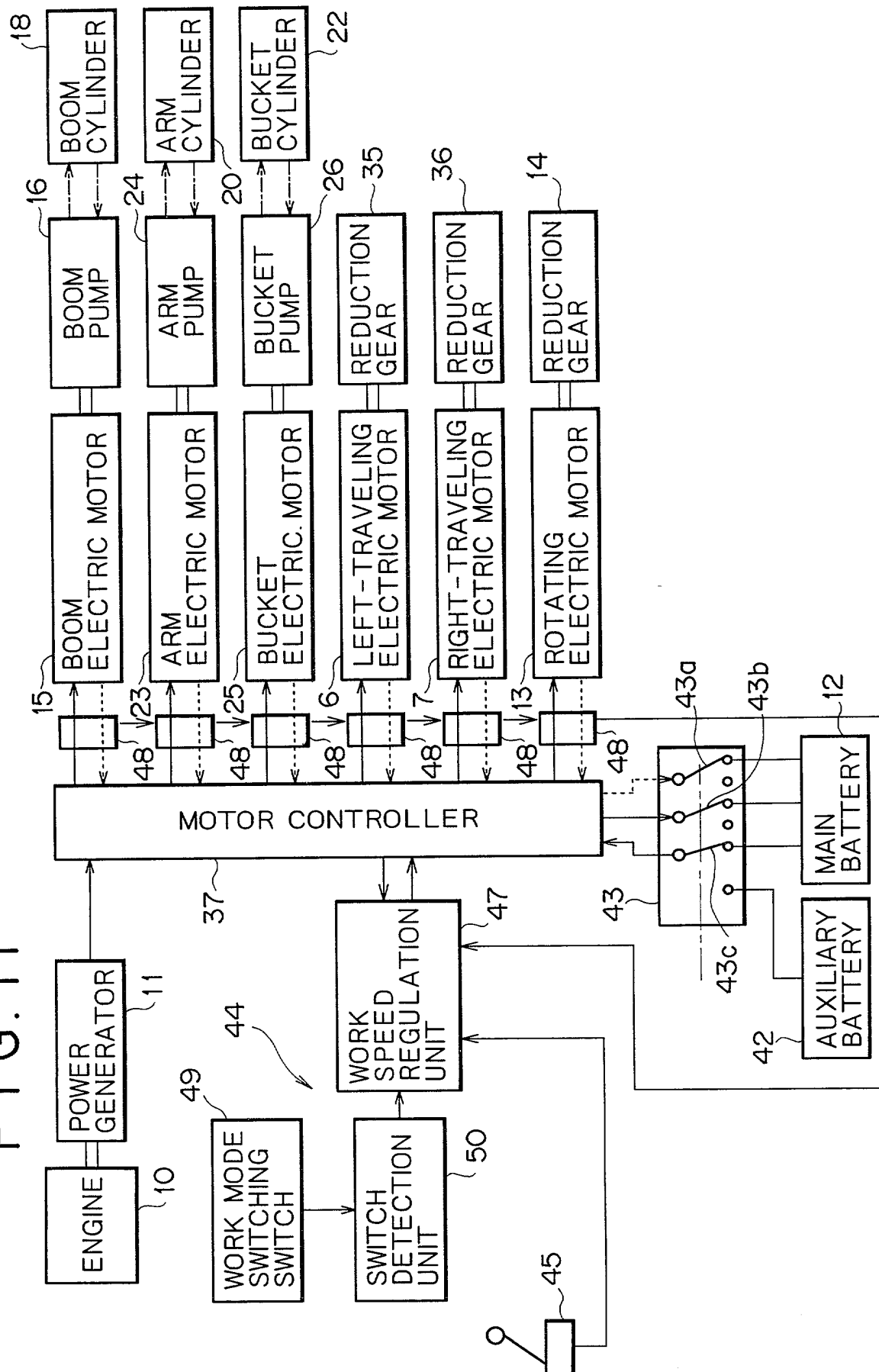
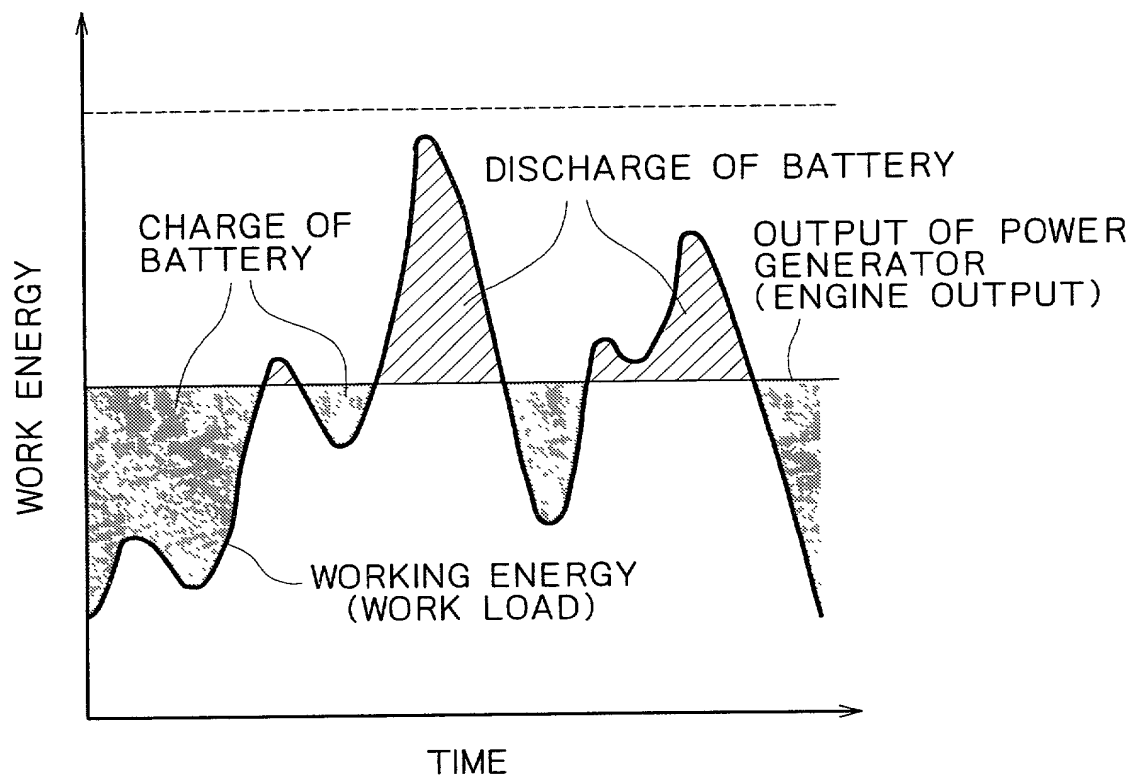


FIG. 12



Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者（下記の名称が複数の場合）であると信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled.

HYBRID CONSTRUCTION MACHINE AND CONTROL APPARATUS THEREOF

上記発明の明細書は、

- ☐ 本書に添付されています。
- ☐ ____月____日に提出され、米国出願番号または特許協定条約国際出願番号を____とし、
(該当する場合) ____に訂正されました。

the specification of which

- ☒ is attached hereto.
- ☐ was filed on _____
as United States Application Number or
PCT International Application Number
_____ and was amended on
_____ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第 37 編第 1 条 56 項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulation, Section 1.56.

Japanese Language Declaration

(日本語宣言書)

私は、米国法典第 35 編 119 条 (a) - (d) 項又は 365 条 (b) 項に基づき下記の、米国以外の国の少なくとも一カ国を指定している特許協力条約 365 (a) 項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

Prior Foreign Application(s)

外国での先行出願

Number 番号	Country 国名	Month/Day/Year Filed 出願年月日	Priority Claimed 優先権主張
0011-179681	JP	June 25 1999	YES
0011-179683	JP	June 25 1999	YES
0011-179682	JP	June 25 1999	YES

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

私は、第 35 編米国法典 119 条 (e) 項に基づいて下記の米国特許出願規定に記載された権利をここに主張いたします。

(Application No.)
(出願番号)

(Filing Date)
(出願日)

私は、下記の米国法典第 35 編 120 条に基づいて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約 365 条 (e) に基づく権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第 35 編 112 条第 1 項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その先行米国出願書提出日以降で本出願書の日本国内または特許協力条約国際提出日までの期間中に入手された、連邦規則法典第 37 編 1 条 56 項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

(Application No.)
(出願番号)

(Filing Date)
(出願日)

PCT/JP00/04073

June 21, 2000

私は、私自信の知識に基づいて本宣言書中で私が行なう表明が真実であり、かつ私の入手した情報と私の信じることに基づく表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第 18 編第 1001 条に基づき、罰金または拘禁、もしくはその両方により処罰されること、そしてそのような故意による虚偽の声明を行えば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.)
(出願番号)

(Filing Date)
(出願日)

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application.

(Status: Patented, Pending, Abandoned)

(現況：特許許可済、係属中、放棄済)

☐

Patented

☒

Pending

☐

Abandoned

I hereby declare that all statements made herein of my own knowledge are true and that all statement made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration

(日本語宣言書)

委任状：私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。
(弁護士、または代理人の指名及び登録番号を明記のこと)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: (list name and registration number)

30

Normal F. Oblon, Registration Number 24,618; Mavin J. Spivak, Registration Number 24,913; C. Irvin McClelland, Registration Number 21,124; Gregory J. Maier, Registration Number 25,599; Arthur I. Neustadt, Registration Number 24,854; Richard D. Kelly Registration Number 27,757; James D. Hamilton, Registration Number 28,421; Eckhard H. Kuesters, Registration Number 28,870; Robert T. Pous, Registration Number 29,099; Charles L. Gholz, Registration Number 26,395; Vincent J. Sunderdick, Registration Number 29,004; William E. Beaumont Registration Number 30,996; Steven B. Kelber, Registration Number 30,073; Robert F. Gnuse, Registration Number 27,295; Jean-Paul Lavalleye, Registration Number 31,451; Stephen G. Baxter, Registration Number 32,884; Martin M. Zoltick, Registration Number 35,745; Robert W. Hahl, Registration Number 33,893; Richard L. Treanor, Registration Number 36,379; Steven P. Weihrouch, Registration Number 32,829; John T. Goolkasian, Registration Number 26,142; Marc R. Labgold, Registration Number 34,651; William J. Healey, Registration Number 36,160; Richard L. Chinn, Registration Number 34,305; Steven E. Lipman, Registration Number 30,011; Carl E. Schlier, Registration Number 34,426; James J. Kulbaski, Registration Number 34,648; Catherine B. Richardson, Registration Number 39,007; Richard A. Neifeld, Registration Number 35,299; and J. Derek Mason, Registration Number 35,270; and Surinder Sachar, Registration Number 34,423, with full powers of substitution and revocation.

書類送付先

Send Correspondence to:

OBLON, SPIVAK, McCLELLAND, MAIER & NEUSTADT, P.C.
FOURTH FLOOR
1775 JEFFERSON DAVIS HIGHWAY
ARLINGTON, VIRGINIA 22202 U.S.A.

直接電話連絡先：(名前及び電話番号)

Direct telephone Calls to: (name and telephone number)
(703)413-3000

唯一または第一発明者	1-4	Full name of sole or first inventor Masayuki KAGOSHIMA
発明者の署名	日付	Inventor's signature ✓ Masayuki Kagoshima Date December 17, 2001
住所		Residence c/o Kobe Corporate Research Laboratories in Kobe Steel, Ltd 5-5, Takatsukadai 1-chome, Nishi ku, Kobe-shi, Hyogo 651-2271 Japan JAX
国籍		Citizenship JP
私書箱		Post Office Address SAME AS ABOVE
第二共同発明者		Full name of second joint inventor, if any
第二共同発明者の署名	日付	Second Inventor's signature Date
住所		Residence
国籍		Citizenship
私書箱		Post Office Address

(第三以降の共同発明者についても同様に記載し、署名すること)。

Supply similar information and signature for third and subsequent joint inventors.)